CHANGE IN LAND USE AND LAND COVER AND ENVIRONMENT OF HUBLI-DHARWAD TWIN CITIES IN THE WAKE OF URBANIZATION—USING GEOSPATIAL TECHNIQUES

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Most of the urban centers in the world are expanding to accommodate over flowing population, and this in turn is causing drastic change in the nature of the landscape of the cities. Urbanization is a process which is taking place at a high rate with or without proper planning strategies (Hagerstand, 1995). Unplanned expansion of cities have created unsolvable issues like conversion of agricultural lands, reclamation of water bodies, creation of slums, generation of urban solid and liquid waste, etc. These issues are attracting the attention of Urban/environmental researchers for finding appropriate measures to create a healthy environment for residents. The authors have selected Hubli-Dharwad twin cities to study the process of urbanization and its impact on morphology and environment. In the recent past, morphology of the study region has been undergoing rapid change due to rapid growth of population and establishment of industries. This change has occurred all along the National Highway and in and around Hubli-Dharwad city for commercial, administrative and residential purposes. An attempt has been made here to classify the satellite images for land use and land cover and find out the temporal variation, and an attempt is also made to understand the impact of urban changes on environment, particularly alteration in temperature and rainfall. The morphological changes have been analyzed by using LANDSAT, TM (1975 and 1989) and IRS LISS III (2011) images at different time period. The satellite images of 1975, 1989 and 2011 are analyzed to detect the temporal changes in the land use and land cover. The topographical maps (1 : 50,000), ARC GIS (10) and ERDAS (9.1) software packages are used to process the satellite images, generate data and preparation of final layout. The study makes use of Bands 1, 2, 3 and 4 of LANDSAT, TM and IRS LISS III data with spatial resolution of 30 M and 23 M respectively.

It has been noticed that land use in Hubli-Dharwad city has undergone significant changes within a span of three decades. This change is due to over flowing population and establishment of industries. The changes are mainly observed through the agricultural area and water bodies reclaimed for built up area and industrial purposes. During 1975, the study area recorded about 4,914.11 hectares of Agricultural land, and in 2011 it has decreased to 2,320.39 ha. It is witnessed that within a span of 36 years, about 2,593.72 hectares of agricultural land has decreased. There is a phenomenal increase in the Built up area from 1,080.94 hectares (1975) to 3,852.78 (2011). The study area is known for its water bodies and there were more than 100 small and big water bodies and these water bodies maintained healthy climate of the city and provide water for its residents and domestic animals; however, due to rapid growth of urbanization these water bodies

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are reclaimed for residential and industrial purposes. As a result hardly few water bodies are left, and a visible change in temperature and rainfall could be noticed in the twin cities. Another aspect of these changes is that the cities are facing scarcity of drinking water which was once known for surplus water supply.

INTRODUCTION

Urban area in all parts of the world is subjected to various changes such as physical landscape, socio-economic, environmental, etc. These changes are universal phenomena taking place due to over flowing population, industries, vehicles, etc. The process of urbanization is taking place at a drastic rate with or without proper planning strategies (Hagerstand, 1995). Unplanned outgrowth and expansion of cities have serious impact on the local ecology and on the substances of natural resources (Ramachandra, 2012). The impact of urban expansion is observed on large scale on physical environment particularly on conversion of agricultural land, reclamation of water bodies, creation of slums, generation of solid and liquid wastes, etc. These rapid changes are attracting the urban and environmental researchers for finding appropriate measures to create healthy environment for the residents.

Bharath (2012) examined that the rapid urbanizing landscapes with high population density often face several crises due to inadequate infrastructure and lack of basic amenities. To check the growth of unplanned urban areas at local and global scale has become urgent task of urban researcher to find out the controlling measures in order to mitigate urban problems. Overall information pertaining to urban changes is critical to sustainable urban land use planning and management (Bannasly and Barr, 1996). Such information is available in documenting urban growth and improving urban land use plans (Bullard and Johnson, 1999).

Traditional survey and mapping methods have been used for urban planning and management for a long time. These methods are often time consuming, tedious and expensive (Rawashdeh and Saleh, 2006). Remotely sensed satellite data having a good spatial and spectral resolution required over frequent time interval is all the most widely used tool. The remotely sensed data offer permanent and authentic record of spatial pattern, which is valuable for verification and assessment purpose (Prakash and Gupta, 1998). Keeping this in view, digital image processing techniques are used to detect the changes in land use of Hubli-Dharwad twin cities. This study may help in decision making for sustainable urban development.

THE STUDY REGION

Hubli-Dharwad twin cities are 20 km apart, lies on the Deccan plateau in North-western Karnataka. They were independent towns till they were merged into a single municipal corporation in 1962. Many villages like Rayapur, Unkal, Bairidevarkoppa, Navanagar, Nuggikeri, Kelgeri, Yettingudda etc. are merged subsequently. Now it covers an area of 202.28 sq. kms and its population is 9,43,788 in 2011. The area covered by Hubli-Dharwad Municipal Corporation has undulating topography with height varying from 600 to 750 meters above mean sea level.

Hubli-Dharwad twin cities are located between 15°31′5″ North to 15°20′30″ North latitudes and 74°54′25″ East to 75°10′25″ East longitudes with total area of 214.28 sq. kms (2011) as against 41.86 sq. kms (1961) of earlier area (Fig. 1). After the merger of Hubli and Dharwad towns under a single municipal the growth has been enormous. The actual distance between Dharwad and Hubli is 20 kms. Today it is the fastest growing cities in Karnatak next to Bangalore. The climate in this area is pleasant though minimum temperature rise to 37°C in April. June to September is the

main rainy season with about 60 per cent of total annual average rainfall of 81.9 cm at Dharwad and 69.68 cm at Hubli.

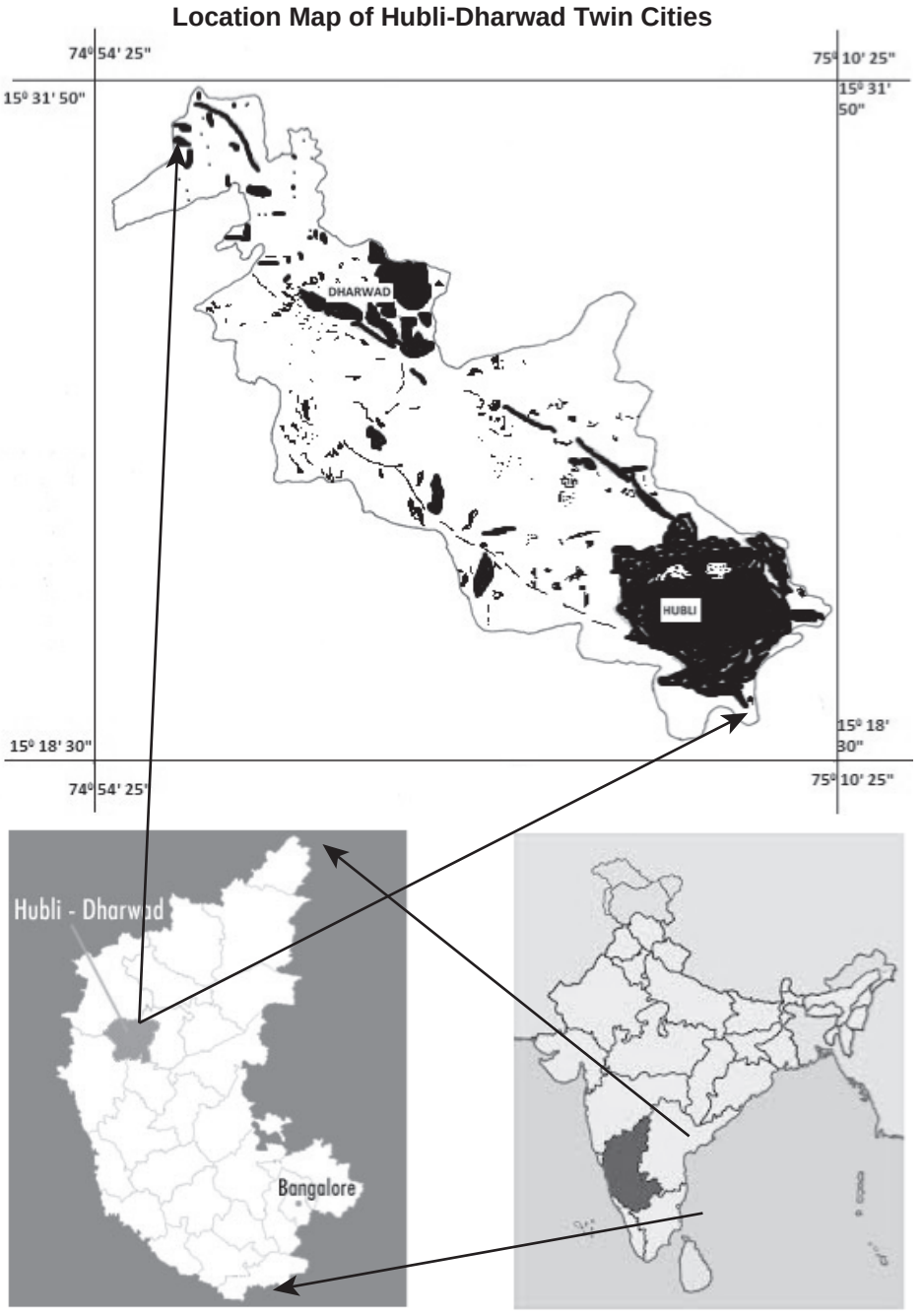

Fig. 1

OBJECTIVES

The specific objectives of the present investigation are:

To identify the spatio-temporal dynamics of land use of Hubli-Dharwad twin cities using satellite images and geospatial techniques.

To analyze the changes in climatic conditions particularly temperature, rainfall, humidity, etc.

To analyze the process of urbanization and factors responsible for environmental changes.

HYPOTHESIS

The following hypotheses are being formulated to achieve the above mentioned objectives.

There is positive correlation between the process of urbanization and environment of Hubli and Dharwad twin cities.

The areal expansion is associated with size of population and negative impact on existence of water bodies.

DATA BASE AND METHODOLOGY

The change in land use and land cover for about 36 years of time period was analyzed by using satellite images of 1975, 1989 and 2011. The two year image i.e. 1975 and 1989 LANDSAT. TM images are downloaded from Earth Explorer and IRS LISS III (2011) image was downloaded from Bhuvan. After scanning topographical map $(1:50,000)$ of study area it was georefered by using Arc GIS 10 software.

At the beginning the base map of the study region was prepared with the help of topographical map $1:50,000$ scale. The study area spread over four topographical maps i.e. 48 M/2, 48 M/3, 48 M/14 and 48 I/15. To analyze the changes in land use and land cover and their spatio-temporal pattern, a set of three satellite images were acquired for the years 1975, 1989 and 2011. LAND SAT. Thematic mapper (TM) images were downloaded through Earth Explorer for the year 1975 and 1989. For the year 2011 IRS P6 LISS III image was selected for the analysis.

The sub setting of satellite image was performed for extracting study area by taking geo referred outline boundary of Hubli-Dharwad municipal corporation map. The subset images are then re-projected. The downloaded satellite images are used to plan the survey in the study area using FCC (False Color Composite) format. The tracing data are collected from field using GPS survey technique. The GPS points are downloaded and overlaid on the imagery and used for further image processing.

Digital analysis of land use and land cover changes has been carried out through FCCs of study region. The rectified satellite images of the study area are then classified in ERADAS 9.1 software, and with the help of training data collected from various training sites are applied to entire image, and multispectral pixels of the study area images are classified into five broad land use classes i.e. 1) Builtup area, 2) Agricultural land, 3) Water bodies, 4) Waste land (open shrubs and terrain), and 5) Vegetation.

RESULTS AND DISCUSSIONS

Built-up area, water bodies, adjusted agricultural land, waste land (open shrubs and terrain), and vegetation are some of the important salient features of major urban areas and it is generally accepted as the parameters for quantifying urban sprawl (Torrens and Alberti, 2000). Image

extraction, rectification, restoration, and classification are the standard image processing techniques used in the present study to delineate land use and land cover of Hubli-Dharwad twin cities. Sampling training points were identified in the field by using Global Positioning System (GPS) receiver and corresponding attribute data was obtained by field observation and interaction with the local people. Based on these evidences, and various land features, image classification is done and land use and land cover area zones are extracted for the year 1975, 1989 and 2011.

LAND USE AND LAND COVER CHANGES

Land use and Land cover are dynamic words used for the analysis of salient features of land. These are closely related but not mutually exclusive. They are interchangeable as the land use is inferred based on the land cover but there should not be any confusion in the use and interpretation of these two terms.

Land use: Series of activities on land carried out by humans with intension to obtain products or benefits through the use of land.

Land cover: Land cover refers to the characteristics of Earth's surface, as represented by natural elements. Vegetation, ice, water, sand etc. is some of the examples.

The present land use and land cover has been analyzed in two phases. Phase I analysis the changes occurred during the period of 1975 to1989 and Phase II analysis the period of 1989 to 2011.

The total geographical area along with its land use and land cover has changed over the decades. The administrative boundary of Hubli-Dharwad district has also increased after 1989. From the Fig. 1 and Table 1, it is seen that the total geographical area has increased to 7875.9 hectares from 1975 to 2011.

Table 1: Land Use and Land Cover in Hubli-Dharwad Twin Cities (Area in Hectares)

Sl. No.	Land Use and Land Cover Categories	1975	1989	Changes from 1975 to 1989	2011	Changes from 1989 to 2011	Overall Changes (1975–2011)
1	Agricultural land	4914.11 (35.42%)	3582.92 (16.47%)	−1331.19 (27.09%)	2320.39 (10.67%)	−1262.53 (35.24%)	−2593.72 (52.78%)
2	Water bodies	221.582 (1.60%)	156.196 (0.72%)	−65.386 (29.51%)	202.207 (0.93%)	46.011 (29.46%)	−19.375 (8.74%)
3	Waste lands (open shrubs and terrain)	4,957.65 (35.73%)	11,243 (51.67%)	6285.35 (126.78%)	9480.39 (43.61%)	−1762.61 (15.68%)	4522.74 (91.23%)
4	Buildup	1080.94 (7.79%)	1928.93 (8.87%)	847.99 (78.45%)	3852.78 (17.72%)	1923.85 (99.74%)	2771.84 (256.43%)
5	Vegetation	2700.24 (19.46%)	4846.37 (22.27%)	2146.13 (79.48%)	5884.77 (27.07%)	1038.4 (21.43%)	3184.53 (117.94%)
	Total	13,874.522 (100%)	21,757.416 (100%)		21,740.537 (100%)		

Sources: Author computed from the LISS III (23 meter resolution) and Land sat TM (30 meter) resolution.

Note: Figures in the brocket show percentile of area.

Hubli and Dharwad were two separate towns before 1962. On March 2nd, 1962 these towns were merged into one municipal corporation, at that time the total area was 180.1 sq. kms with

a population of 2,48,489. Urban Development Authority was constituted in 1966 for proper and planned growth of Hubli-Dharwad municipal corporation area. The total area of twin cities was 182.30 sq. kms in 1975 but the population was 3,80,100. In 1981 the total area of Hubli-Dharwad twin cities was increased to 192.03 sq. km and the population increased to 5,28,011, during the period of time 15 surrounding villages are merged into municipal corporation area. In the year 2001 the total area of twin cities was increased to 202.00 sq. kms and the population was reached to 7,86,089. During 2011, 25 small village came under municipal limitation, as a result, the total area rose to 214 sq kms and population was 9,43,788.

Phase I 1975 to 1989: This phase covers a period of 14 years. The land use and land cover change pattern have been identified with the help of survey of Indian toposheets, and Satellite images were downloaded from earth explorer for 1975 and 1989. The study area covers an area of 21,757.416 hectors. During this phase positive changes are noticed in built up area, vegetation and wastelands and negative changes were recorded in agriculture and water bodies. Table 2 show that total area under agriculture was about 4,914.11 hectares in 1975 which decreased to 3582.92 hectares in 1989, the net decrease by 2,593.72 hectares (27.09%) within a span of 14 years. This happened because of increase in the built up area, waste land and area under vegetation. During this period many water bodies are reclaimed for residential, commercial and industrial purpose, which results in decrease of water bodies by 65 hectares (29.51%). It has been noticed that about 285.3 (126.78) %) hectares of wasteland increased (Fig. 2).

Table 2: Changes in Land Use and Land Cover in Hubli-Dharwad Twin Cities, 1975–2011

Sl. No.	Years	Agricultural Land (%)	Water Bodies (%)	Waste Lands (Open Shrubs and Terrain)(%)	Buildup (%)	Vegetation (%)
1	Changes from 1975 to 1989	27.09 (−ve)	29.51 (−ve)	126.78 (+ve)	78.45 (+ve)	79.48 (+ve)
2	Changes from 1989 to 2011	35.24 (−ve)	29.46 (+ve)	15.68 (−ve)	99.74 (+ve)	21.43 (+ve)
3	Overall Changes (1975–2011)	52.78 (−ve)	8.74 (−ve)	91.23 (+ve)	256.43 (+ve)	117.94 (+ve)

Sources: Author computed from the LISS III (23 meter resolution) and Land sat TM (30 meter) resolution.

Normally the trend for wasteland shows negative growth as the built up area increases and occupies the waste lands but in the present study along with growth of built-up there is growth in waste land too. It may be due to the fact that many surrounding villages come into the city limit, and many builders purchased the land and kept vacant. Total area of built up area has increased from 1,080.94 hectares in 1975 to 1928.93 hectares in 1989. This particular category net increased by 847.99 hectares. In the early nineties there were hardly any apartments in Hubli and Dharwad towns, but within a span of 15–20 years more than 250 apartments and complexes have come up. With increase in built up area "Heat Islands' have developed (Nayak and Hymavathi Reddy, 2004). For the first time city has recorded temperature of 3°C more than the average during 2010. It is interesting to note that no deforestation activities reported in the study area, as a result, the area under vegetation has increased from 2700.24 hectares in 1975 to 4846.37 in 1989. This is due to the fact that many mango orchards have come up at the out skirts of the city. It is a healthy sign to maintain the balance in the environment.

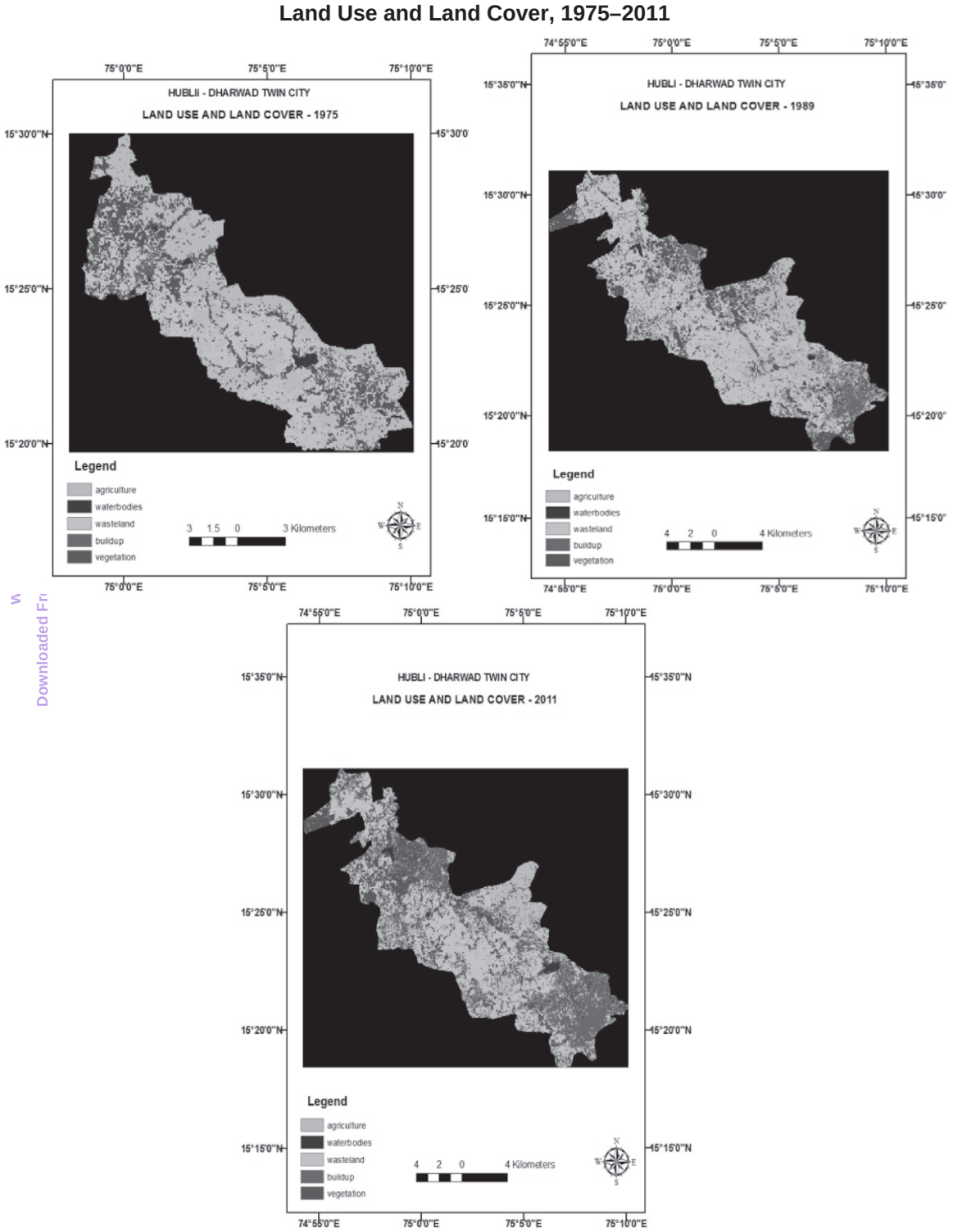

Fig. 2

The growth of cities has taken a heavy toll on sanitation and created a severe shortage of water supply. Earlier, several tanks and ponds that met the full needs of population, have become polluted and being constantly reclaimed for construction purposes. Now, only three large tanks survived but suffering from pollution.

Hubli city has developed predominantly in South, West and all along the National Highway No. 4 towards Dharwad city where as, Dharwad city is developing in all direction, however, there is very slow development towards North as the area does not show favorable condition for built up. Between both cities, most of the central and state government offices have come into existence. Apart from this industrial area has also developed.

Phase II 1989 to 2011: Second phase studies the changes of land use and land cover which took place during 1989 to 2011. This notable period follow the same pattern of changes as in the first phase. Built up area, water bodies, and vegetation show positive changes where as agricultural land and waste lands show negative changes as most of the land converted into build up. The land under agriculture has decreased by 35.24 per cent, during 1989 it was 3582.92 hectares and it decreased to 1262.53 hectares in 2011 (Table 2 and Fig. 4), the built up area was increase by 99.74 per cent (Fig. 5). The trend and extent of twin cities is likely to continue with development of water bodies and vegetation by 29.46 per cent and 21.43 per cent respectively. Changes show that the corporation has taken certain measures to develop the existing tanks and maintain greenery in the cities by increasing area under vegetation during 1989–2011 (Fig. 6). Waste land occupied 11,243 hectares in 1989 and it reduced to 9480.39 hectares (Fig. 7). The decrease in waste land is considered as healthy sign as the waste land is utilized for one or the other purposes.

The overall changes in land use and land cover for a period of 36 years show negative change in agriculture (−52.78%), and water bodies by 52.78 per cent and 8.74 per cent respectively. Built up area indicates maximum change with 256.43 per cent followed by vegetation by 117.94 per cent (Fig. 3).

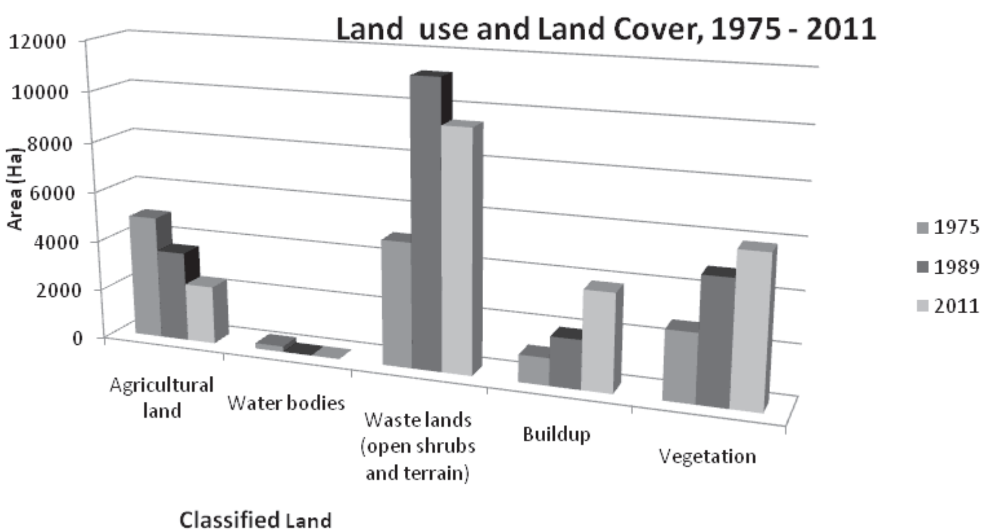

Fig. 3

Land use and land cover changes are essential components for the development of a district. It has negative consequences but, it is necessary to balance the natural environment and developmental activities. Degradation of environment, depletion of natural resources i.e. vegetation, water bodies, etc, increasing buildings and climatic change are some of the changes faced by this district.

Change in Agriculture

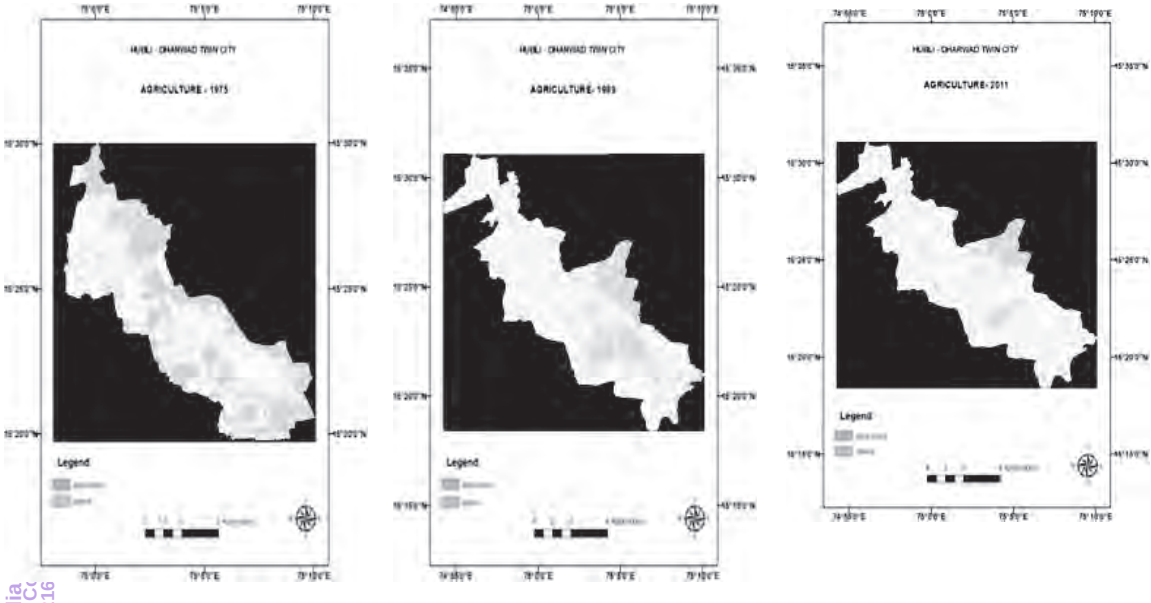

Fig. 4

Change in Builtup Area

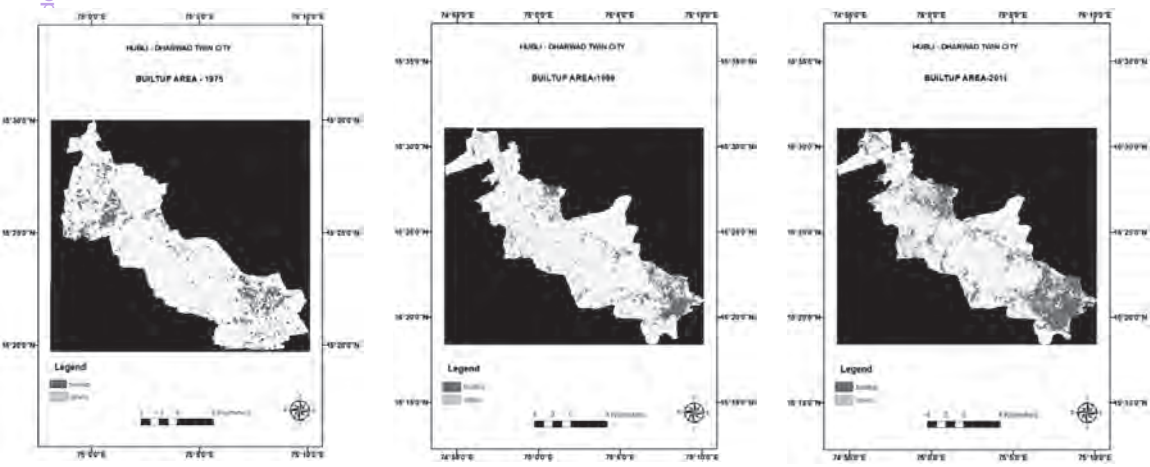

Fig. 5

Change in Vegetation

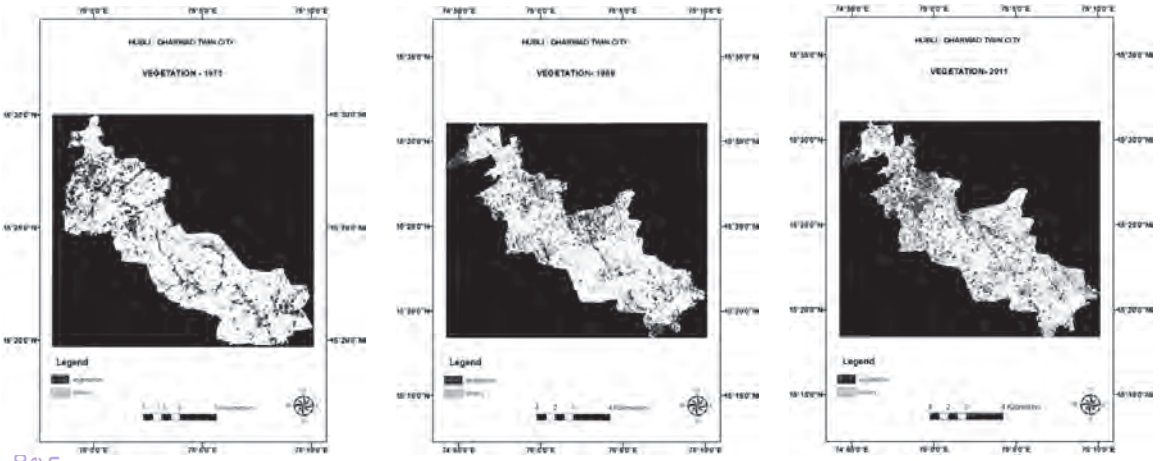

Fig. 6

Change in Waterbodies and Wasteland

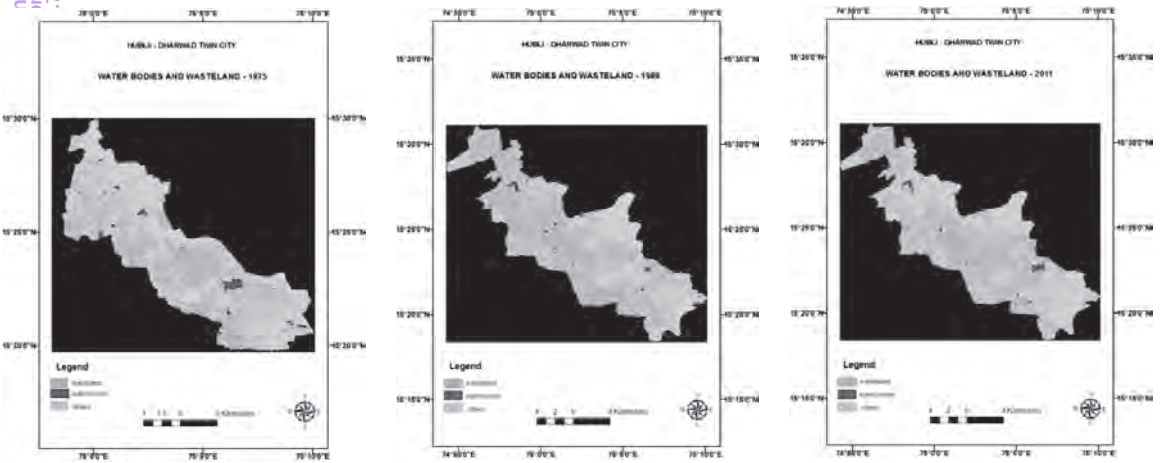

Fig. 7

CHANGE IN CLIMATIC CONDITION

Ever increasing urban population, vehicles, industries etc. are responsible for most of the agglomeration of the world, and have become heat islands by consuming large quantity of energy, and consequently releasing large amount of polluting substance added to atmosphere, water and soil. The quality of weather in the urban areas could be measured by assessing the presence of foreign substances present in the normal air. We have examined the climatic conditions including temperature, rainfall, humidity etc. and pollution, during the period 1975 to 2011 i.e., a duration of 36 years. This is the period during which drastic changes in Hubli-Dharwad have taken place in terms of modern industrialization, development in infrastructural facilities and morphological development.

It is generally believed that interactions of human beings with the environment are enormously complex and subsequently changes the environment.

1975

Elements	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
Max C°	29.8	32.6	32.6	36.3	36.7	27.6	26.2	25.6	28.6	31.4	29.8	29.3	30.5
Min C°	14.7	17.7	19.2	21.0	21.4	21.2	20.7	20.2	19.7	19.0	16.6	13.9	18.8
R.H.%	71	73	61	85	90	92	84	90	83	64	61	56	76
R.F.	0.0	0.0	0.0	109.5	33.5	159.2	202.2	149.4	127.2	43.5	23.0	0.5	848%

1989

Elements	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
Max C°	30.3	33.2	34.3	37.2	35.7	28.3	27.3	26.4	28.8	31.2	29.8	29.1	31.0
Min C°	76	15.0	18.4	20.2	20.7	20.3	20.0	19.6	19.2	18.3	14.9	13.7	17.8
R.H.%	0.0	70	67	64	65	83	86	87	80	73	78	77	75
R.F.	12.1	0.0	3.8	7.2	46.8	97.7	185.7	61.6	82.9	7.5	44.4	7.4	545.6

2011

Elements	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
Max C°	30.7	33.2	36.0	36.3	37.0	30.9	27.4	27.1	27.5	29.6	29.4	28.9	31.16
Min C°	15.0	16.3	18.9	21.3	21.5	21.5	21.4	20.4	20.3	19.1	14.9	13.1	18.60
R.H.%	49	43	42	53	55	76	83.0	81	85	70	51	53	62
R.F.	4.8	Tr	Tr	75.0	29.4	151.0	290.2	138.8	194.5	89.4	38	Tr	1011.1

Source: Indian meteorological Dept. and University of Agricultural Science, Dharwad.

The industry, housing, vehicle etc. important urban complexes create local modifications to the earth's surface and atmosphere. In most urban areas air temperature recorded near their centers of activity where building density and height are usually highest. The local climate of Hubli-Dharwad has been analyzed considering the annual average of temperature and rainfall. During 1975 the mean annual temperature of Hubli-Dharwd urban region was 30.5°C. The mean maximum temperature of the study area varies from 27°C to 33°C and the minimum temperature varies from 16°C to 25°C. In 1989 and 2011 the mean annual temperature has increased to 31°C and 31.16°C respectively. The mean annual temperature recorded for the entire region reflects marginal change temperature by 0.16°C during a period of 36 years i.e., from 1975 to 2011. But the temperature recorded in the entire part of Hubli-Dharwd urban system exhibits variable temperature conditions. The measurement has been made to know the temperature variation between central streets and surrounding areas. The record shows 1.9°C higher temperature than the surrounding areas.

The occurrence of rainfall in the area under study was highly uncertain. The year 1975 received an annual rain fall of 848 mm. During 1989 it has decreased to 545.6 mm and in 2011 it increased to 1011 mm. It is observed that though there is high fluctuation in the rain fall from year to year and decade to decade there are no drastic changes in weather condition of Hubli-Dharwad region.

Air is a natural gift to the living organisms. If it gets polluted it can cause serious respiratory diseases, physical damage, loss of vision, even death etc. The air quality degrade mainly due to the developmental progress especially industrial emission, increasing number of motor vehicles and poorly maintained vehicles, use of unleaded petrol etc. The study area, registered 939 industries in 2011 where as, in 1989 there were hardly 485, most of them are engineering in nature, of these only 71 and 21 industries covered under hazardous waste management rules and under plastic manufacturing rules respectively. The total number of vehicles registered at RTO were 1,78,571 which includes two wheelers, three wheelers, cars, trucks etc. The increase in number of vehicles gives rise to serious Congestion problems on the road and also pollutes the air.

Air Quality Index Values of Two Stations of Hubli-Dharwad Twin Cities-Mg/m^3

Selected Stations	TSPM	RSPM	NO_x	SO_2	AQI Value	State of Air based on AQI
Ranichannamma circle-Hubli (Com. and Heavy traffic zone)	954	293	23	10	29	Light Air pollution AQI-264 and above
Lakamanahalli Industrial Area	92	47	06	02	05	Clean Air AQI blow 22

Hubli-Dharwd twin cities are the second largest urban agglomeration in Karnataka state, spreading over an area of 214.28 sq. kms. The population of Hubli-Dharwad twin cities has increased from 81,143 in 1901 to 7,86,078 in 2011. The number of vehicles were 99,800 (1989) and increased to 2,58,495 in 2011. Under NAMP (National Air monitoring program) 14 stations are being monitored in Karnataka state, of these two stations are located in the study region one at Ranichanamma circle, Hubli (Commercial area) and other one at Lakamanhalli industrial area. The air quality monitoring in these two locations is being carried out at a frequency of twice a week for 24 hours for suspended matter, (spm), Respirable suspended particulate matter (Rspm), sulpher dioxide (SO_2) and Nitrogen Oxides (NO_x), and the air quality index is calculated from the observed elements by using the formula. The air quality is calculated for both the selected stations. The air quality index is classified into two categories i.e., 0–25 (clean air) and 26 and above (light air pollution).

It is noticed that the Rani Channamma circle, Hubli has maximum concentration of TSPCM and RSPM in 2010. It is one of the oldest spot where at different places road takes diversion and most of the vehicles pass through the city form this circle. The maximum concentration at 5 pm in Rani Channamma circle was 392, and 26 Mg/m^3 is the minimum concentration while maximum RSPM in this place is 162, and 12 mg/m^3 is the minimum. Lakamanahalli industrial area has maximum TSPM concentration of 550 and 32 mg/m^3 of minimum and the TSPM concentration of maximum RSPM 224 and minimum of 12 mg/m^3. The stations were found within the permissible limit of 80 mg/m^3.

CONCLUDING REMARKS

A proper planning and management of urban space can minimize the adverse effect on environment. The land use and land cover of Hubli-Dharwad cities has been extended over a large area after merging of two towns in single Municipal Corporation and the establishment of urban development authority. A lot of negative changes have taken place in agricultural land where as, build up area recorded tremendous positive change. Similarly negative and positive changes are also marked in other urban features. Before 1962, the total area was 180.1 sq. km. with a population of 2,48,489. In 1981 the total area of Hubli-Dharwad twin cities had increased to 192.03 sq. km and the population increased to 5,28,011, during this period of time 15 surrounding villages were merged into municipal corporation. In the year 2001 the total area of twin cities increased to 202.00 sq. km. and the population reached to 7,86,089. During 2011 as many as 25 small villages came into municipal limitation, as a result the total area rose to 214.24 sq. km. and population shot to 9,43,788.

Among all the morphological units agricultural land show declining trends from 4,914.11hectares in 1975 to 1,262.53 in 2011 hectares, within a span of 36 years more than 50 per cent of land has decreased and built up area has increased from 1080.94 hectares in 1975 to 3852.78 hectares in 2011, it depicts that more than 100 per cent change has taken place in this category. Land under vegetation has recorded impressive positive change and that is healthy symbol for the urban growth

and its environment. It is a general trend that the city grow by utilizing agricultural and waste land as a result the area of these two urban feature certainly decrease, but it is not so in case of waste land of the study region. In fact waste land has increased rather than decrease, the fact is that many builders purchased the agricultural, and other land, residential and industrial layout but due to one or the other reasons the land is kept vacant for decades and hence waste lands maintained its pace of growth.

Human activities certainly have its impact on any kind of land forms and the urban land undoubtedly changes. The record shows 1.9°C higher temperature than surrounding areas. Urban heart land generates the heat due to human activities and vehicles. It is recorded that the temperature of the heart land Hubli-Dharwad cities is 1.9°c higher than the surrounding areas. It is observed that the average annual rainfall has decreased by 30–40 mm. The concentration of Respirable suspended particulate matter (Rspm), sulpher dioxide (SO_2) and Nitrogen Oxides (NO_x) and other particulates have increased as a result not only air quality lost but also temperature has gradually increased.

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